ATLANTIC BIOLOGICAL STATION

St. Andrews, N.B.

The ultimate aim of the fisheries biologist is to discover how to exploit the fisheries resource to the fullest possible advantage of our society, being closely allied in this endeavour with the economist, the administrator and the industry. With human populations increasing more rapidly than their supplies of animal protein, there can be little doubt of the long-term need for increased production. The problem itself, however, is complex and has not only scientific but also administrative and economic aspects, all three being inseparable. The Station in its work is therefore closely associated with various branches of the fisheries administration and of the industry. Its work should be judged only as part of a joint attack on the fisheries problem as a whole.

The need is to learn how to get more or better fish economically. As most branches of our fisheries are underdeveloped, emphasis is needed on improvement of production and capture rather than on restriction of fishing to protect the long-term yield. In a very few cases we can so alter the conditions under which fish grow as to increase their abundance in a manner akin to farming. More often we must learn how to find fish better by exploring for new species or stocks and discovering more about the occurrence and movements of all valuable kinds. We must also learn how to catch fish more efficiently by studying the operation of kinds of gear new or familar, and by learning how successful catching is influenced by the activities of the fish. In a very few cases there is evidence that restriction might improve long-term yield and intensive critical work is needed to lay the basis for restricting only those fisheries of which this is true. We must also learn how to improve quality, protect public health and help the holding and transport of species marketed alive. Work on all these biological aspects of the problem of fisheries development is included in the Station's program.

POSITIVE CULTURAL MEASURES. The cases in which the production of fish or shellfish can be increased by positive cultural or "farming" measures speak for themselves. They are limited to fresh waters and inshore areas where some control of the environment is possible. Successes have been achieved in oyster farming, an industry having been established on the basis of our findings. Successes are emerging in the cases of trout, salmon and smelt. Investigations of soft-shelled clam farming have failed to confirm prospects for success based on supposed profitable operations elsewhere. Investigations are proceeding actively on positive measures to produce oysters, salmon and trout, but are coming to an end in the case of clams and smelt.

EXPLORATION. To explore the fisheries resources of our waters is a slow and difficult task with our limited boats and personnel. It has been shown, however, that efforts in this direction can pay well. The Station's explorations led to the establishment of new flounder and scallop fisheries. They have played

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an important part in the establishment of the Irish moss industry and the expansion of the clam industry, starting small bait-worm and razor-clam fisheries. It has been shown that fat herring can be caught in good quantities in the Gulf of St. Lawrence over a four-month season. On the other hand, explorations failed to reveal good commercial quantities of shrimps or bar-clams. Explorations are continuing actively for herring (off the outer coast of Nova Scotia), groundfish (for small draggers) and other species.

Search for commercially valuable fish stocks can be successful only if it is supported by knowledge of the physical environment and of the habits of the fish. It depends on the current and accumulated results of investigations on hydrography and on the lives and activities of the valuable species.

FISHING METHODS. The fishing industry of the Canadian Atlantic coast has much to learn of fishing methods, old and new, and improvement in catching efficiency is important to its successful competition with other fisheries and, indeed, food industries. The Station has helped to meet this need by testing and demonstrating fishing gears developed elsewhere and by attempting to develop still further improvements in techniques.

The introduction of outside methods has met with varied success as should be expected in view of the diversity of conditions for fishing. The Station played an important part in the introduction of long-lining with powered haulers in Nova Scotia and in initiating its later extension Newfoundland—a development of the greatest importance to small-vessel fishing. Danish seining was found to have limited applicability because it needs such smooth bottom, but has proved its commercial worth on a small scale in Chedabucto Bay. The widespread flounder dragging by the Station's small boats stimulated the adoption of this method by inshore fishermen. Demonstration of the value of sonic sounders led to their general adoption in sardine seining in the Bay of Fundy. The effectiveness of the deep drift-nets used in the North Sea has been demonstrated in herring fishing in the Gulf of St. Lawrence but costs appear too high for present price structure. Experiments on the use of special trawls for herring are still proceeding but have already led to the catching of sardines on the bottom in day-time with modified groundfish drags. Gill-netting for groundfish, using powered haulers and modified Great Lakes techniques, was tried but found unpromising.

Improvement of fishing techniques depends ultimately on knowledge of how the gear works and how the fish act. The influence of light on the vertical movement of herring and other pelagic fishes is an important factor and is being studied. Pelagic trawls are in an early stage of development as commercial fishing gear and the Station is co-operating in testing some new designs. The development of a cheap and easily-operated tool for measuring the actual pull on towing warps opens the way for a study now being undertaken of the pulls required to operate various gears under various conditions and of the abilities of boats of various sizes, designs and powers to deliver these pulls. Such information would be very valuable both to fishermen and to those who formulate development policies.

REGULATION OF INTENSIVE FISHERIES. The public, influenced perhaps by the facts of stock raising, has exaggerated the benefits to be expected from the protection of small fish. Farm stock have very small numbers of young, which survive well; fish have very large numbers, which suffer severe mortalities. With the former there is good assurance that saved young will survive and can be found and used at a larger size; with the latter neither survival of saved young nor our ability to find and catch them at a larger size is at all well assured. Failure to catch and keep small fish may simply mean that we lose them. Each case in which it seems that restrictions on fishing designed to let fish grow larger would increase the long-term yield must, therefore, be examined very carefully.

Obviously the better the young survive, the faster they grow, and the better our chance of catching them again, the more likelihood is there that it will pay to protect them. To get information on these points needs intensive work over a long period and, consequently, a high cost whether reckoned in time, money or personnel. We should, therefore, attack only those cases where the chances of restrictions paying are good or where the stakes are very high. Even in these cases a great deal of work may have what may be the very valuable, but is nevertheless the rather intangible, result of avoiding damaging restrictions.

Work of this kind is proceeding in the cases of the lobster where there is evidence that size limits can be valuable, the clam and the scallop, which appear now to be somewhat more doubtful cases, and groundfish, where more fishing seems desirable but where either undesirable restrictions or over-fishing might possibly occur and the stakes are very high. Harp seals which, being mammals, have a low reproductive rate which sets them apart from the other cases by making maintenance of the parent stock more important, are also being studied to assess the need for restrictive measures.

PROTECTION OF PUBLIC HEALTH. Oysters and clams grow in sheltered inshore waters and pollution makes serious difficulties for these industries. The Station has played a major part in the co-operation between the Departments of Fisheries and National Health and Welfare in investigating the problems posed by pollution and in developing policies which permit the maximum use of the resource without danger to public health. A co-operative investigation is now in progress which promises to develop practical techniques for purifying clams by re-laying in waters free from pollution, and many other aspects of the problem are constantly under review and investigation. Paralytic shellfish poisoning has received the same co-operative study and the Station, having completed the most urgent research in this field, is now withdrawing to an advisory position and leaving implementation of the policies which have been developed to the Conservation and Development Service and the Fish Inspection Laboratory.

IMPROVEMENT OF QUALITY. The frequent presence of round-worms in cod fillets constitutes one of the most important hindrances to marketing them, and cod are the largest source of raw material for our fresh and frozen fish trade. Investigations have revealed the main points in the life history of this worm and

shown that it matures in seals. Efforts are being continued to assess the possibility of reducing the numbers of worms by killing seals. The picture is not promising but the importance of the problem justifies the exhaustion of all reasonable possibilities.

HANDLING OF LIVE LOBSTERS. An increasing proportion of the lobster catch is marketed alive and this branch of the trade suffers from losses in holding lobsters alive at the coast and from the difficulty of keeping them alive right to the consumer. The physical and chemical factors influencing the survival of lobsters are being studied intensively to provide the basis for improving holding conditions and reducing losses. Progress is being made in the development of cheap equipment for holding lobsters alive in aerated artificial sea water—a development which, it is hoped, will greatly assist retail marketing.

Lobsters

The lobster fishery, with an annual value of more than $10,000,000, is by far the most important to the inshore fishermen and, in fact, contributes about half of their income. Stimulated by the development of canning, the fishery was in its early stages of rapid growth at the time of Confederation, the catch reaching a peak of over 80,000,000 pounds in the eighties and declining to less than 30,000,000 pounds in 1918, since when it has fluctuated between 25,000,000 and 50,000,000. The peak was to be expected in an increasingly intensive fishery for a relatively long-lived species and probably depended on fishing an accumulation of old individuals rather than on an annual crop, but the decline from the peak stimulated both investigations and attempts at conservation. The general life history of the lobster was determined; hatcheries founded in the nineties were shown by investigations to be useless and were discontinued in 1917; protection of egg-bearing females was recommended and instituted. Since about 1918 the fishery has remained intensive and has shown fluctuations but no over-all downward trend.

REGULATION OF THE FISHERY. Investigations to answer the question "What restrictions of the fishery, if any, can be confidently expected to improve the yield?" were commenced in 1936 and have been intensive since 1942. The population and the fishery have been studied in eighteen ports and regularly in five. The high porportions caught by the fishery (40% to 80%) have been determined by tagging which also, when combined with special catch statistics, permitted estimations of the populations of legal-sized lobsters. Consistent relationships have been found between population density and catch per effort, and between proportion caught, intensity of effort and size distribution. The tagging or marking of over 100,000 lobsters has shown that, although some gradual spread or individual movement occurs, there is no concerted migration either from area to area or on and off shore and that lobster populations are essentially local in character. Exploratory fishing has failed to reveal any considerable stocks seaward from the areas now fished in the Gulf of St. Lawrence. We thus have a local highly intensive fishery in which one might expect restrictive measures to be more than usually promising. What use then can be made of the great body of information resulting from these investigations?

The Station has been in close touch with the Department on the problems of the lobster industry. Results of its investigations have been used by the Department in considering changes in regulations and the Station played an important part in the Department's serious review of the regulations with the industry in 1952. The investigations have indicated that closed seasons have no value in maintaining the stocks, the highest proportions (up to 80%) being caught in areas with a two-month season, and that the seasons must be decided and their value assessed principally on economic grounds. The immediate effects of size-limit changes have been predicted in a number of instances. Information on moulting has influenced the definition of seasons. In these and other ways the results of investigations are used by the Department.

The principal restrictive measure now in force in order to maintain the yield is the size limit. Economic considerations are important in assessing its merits, lobsters above a pound in weight being more valuable than the smaller lobsters which predominate in the catches in some areas. Evidence in favour of enforcement and possible increase of the present minimum size of 2⅜″ carapace measure (about 7″) is of two kinds: (a) With an annual weight increase of about 50% proportions up to 80% and generally over 50% caught each year and an apparently low natural mortality under present conditions, it may be calculated that a greater total weight would be caught if the lobsters were allowed to grow larger. Since, however, this would increase the numbers of lobsters on the grounds, it might change survival, growth and proportion caught, and neither the effects of any given increase nor the optimum size limit can be predicted for any given place. Any change must, therefore, be regarded as experimental and its effects closely followed. (b) Since the size limit was raised at Fourchu, N.S., from 7″ to about 9″ (total length) the total weight taken has increased very slightly but the value has increased appreciably even when allowance is made for changes in lobster prices generally.

The intensive study of the lobster fishery and populations is being continued in five typical areas in order to assess the results of changes proposed now and in the future. The time appears to be ripe for a carefully planned experimental increase of the size limit if support of a suitable fishing community can be obtained.

COMMERCIAL HOLDING OF LIVE LOBSTERS. An increasing proportion of the lobster catch is being marketed alive and the Station has assisted this branch of the trade by studying the factors governing the survival of lobsters. Some years ago special attention was paid to the transport of live lobsters out of water and the emphasis which these investigations placed on low temperatures and on protection of lobsters from direct contact with melting ice has been valuable to the industry. More recently the factors governing the survival of lobsters in water have been studied intensively. These investigations are still in progress but application of results is already commencing in the holding of live lobsters both on the coast and at the markets.

Experiments on the effects of temperature, salinity and oxygen on the survival of lobsters in the summers of 1949, 1950 and 1951 culminated in 1952 in a large experiment, or series of experiments, in which these three factors

are being varied simultaneously. In this experiment which will be completed in 1953, lobsters are being acclimated to three levels each of temperature, salinity and oxygen—making 27 combinations. On lobsters from each of these lots determinations are being made of the levels of high temperature, low salinity and low oxygen which will kill them—81 determinations, each using 40 lobsters. The results are not yet complete but the experiment has shown that the conditions to which lobsters are acclimated influence their survival under extremes of temperature, salinity or oxygen, and that the effects of the three factors are not independent. Thus, the higher the salinity in which lobsters have been held the higher the temperature they will survive, the lower the temperature the lower the salinity they will survive, the poorer the oxygen supply the lower the temperature needed to kill them. The effects of one factor on another are quite considerable, a difference of ·5% in the salinity, for example, making a difference of 2°C. (3·6°F.) in the lethal temperature.

These experiments, when completed, will lay the basis for sound advice on the conditions under which lobsters should be held on the coast for shipment. They have already explained some losses and suggested remedies. It is planned to make a survey of the conditions under which lobsters are held so that improvements can be recommended where needed.

Another development which may prove of great value to the retailing of lobsters is the successful holding of commercial quantities in tanks with aerated, but not circulated, artificial sea water. Continuing experiments started in 1951, it was found in 1952 that water could be filtered cheaply and safely by using air pressure to force it up through a tube a few inches above the surface and allowing it to drain back into the tank through a filter. Glass wool was found to be unsatisfactory as a filter material as short fibres spread throughout the water and poor survival of lobsters resulted; cotton gauze was satisfactory. Lobsters survived more than three weeks at about 50°F. and the weak survivors of one experiment revived well when transferred to fresh artificial sea water after 26 days. Experiments indicate that in these confined conditions a small rise in temperature above 50°F. may seriously reduce survival time. The industry has already shown much interest and details are available for distribution on request. It is hoped that the results of these experiments will be used to reduce losses of live lobsters in retail marketing.

Variations in abundance of lobster larvae. In order to learn more about the factors governing the abundance of lobsters, systematic towing for lobster larvae has been carried out each summer since 1948 in the northern part of Northumberland Strait. Lobsters remain close to the surface until after they have moulted three times and the four "stages", differing both in size and shape, are caught in a special 12′ x 3′ rectangular plankton net. Since towing technique was standardized in 1949 there has been only a 2:1 variation in the numbers of first-stage larvae caught per tow, but survival has varied greatly, and in 1952, the best year, there were more than twenty times as many fourth-stage larvae per tow as in 1949. An attempt is being made to relate these differences to hydrographic or other causes and to abundance of lobsters when the larvae grow to commercial size five or six years later.

Capture of early bottom stages. Although the four free-swimming larval stages have been caught readily for a number of years, persistent and varied attempts both here and elsewhere have failed to find the earliest bottom stages. It has, therefore, been impossible to study the distribution, abundance or growth of young lobsters for a considerable period. In 1952, using a specially designed heavy-toothed 4-foot drag with small-meshed bag, a total of 432 lobsters were caught in 1 to 5 fathoms off Richibucto, N.B. Most of these were smaller than any taken by commercial gear and, indeed, of sizes very few of which have been reported; 19 were less than $1\frac{1}{2}$ inches in total length. Study of the size distribution of these small lobsters has confirmed earlier estimates of growth made from study of larvae and from marking lobsters of commercial size.

Oysters

The oyster of the eastern coast of North America, *Ostrea (Crassostrea) virginica*, supports one of the largest fishery industries of the world, production of high-quality oysters depending to a large degree on positive cultural methods. The Maritime Provinces of Canada, at the northern limit of this species' range, have a very small production (less than 1% of the whole) and Canada does not supply its own demand. The history of the oyster fishery is exemplified by that of Malpeque Bay, one of our most important oyster producing areas. Starting about 1865 the commercial catches grew rapidly to a maximum of over 30,000 barrels in the eighties and nineties and then declined rapidly to less than 5,000 barrels before 1910. The peak, as in the case of the lobster fishery, was due to the expanding fishery taking accumulated old individuals and the public fishery found an equilibrium based on an annual crop at a very much lower level. A contagious disease introduced in 1914 so decimated the remaining Malpeque oyster stocks that the fishery disappeared. It offered a challenge to re-establishment of the industry by oyster farming, known to be successful elsewhere.

Some early investigations had been conducted in Canada (including the first identification at the turn of the century of the oyster's free-swimming larval stage) but intensive investigations date from 1929 and were centred at first in the Malpeque Bay area where the oyster stocks had not yet recovered enough to support a fishery. There was from the first an unusual degree of co-operation between research, administration and private endeavour, a Fisheries Research Board employee being for twenty years in charge not only of scientific investigations but also of the Department of Fisheries' larger-scale experimental farming and of its field administration of a development policy built around the leasing of ground for oyster farming. Cultural methods from other areas were adapted to our conditions and some new ones developed. In the ten years following the offering of ground for lease in 1932 an oyster-farming industry was established in Malpeque Bay based on the methods and policies developed by research and having a production more than equalling the catch just before the disease. Oyster farming has only a seasonal labour requirement and its returns are slow in coming and fraught with some risk. The labour scarcity, high costs of materials, and assured good incomes in other fields have retarded its development for the past ten years. There is, however, enough good oyster

ground for a much larger industry and, consequently, a challenge to research to find cheaper and surer methods of farming. Since its development in the Malpeque area, oyster farming fostered by the Federal Government has spread to other areas in all three Maritime Provinces and, in addition to the research headquarters at Ellerslie, P.E.I., there are now smaller centres at Shippigan, N.B., and Malagash and Orangedale, N.S.

OYSTER FARMING. Research to meet the developing needs of the industry is continuing, with special attention to reduction of costs. Oysters being immobile, except for a brief larval period, and occurring in shallow, sheltered waters, can be "farmed" by a variety of measures analogous to those of agriculture—seeding, thinning, protection from pests, etc. Some attention is being given to many aspects of the work; some recent highlights are given below.

The Station has continued, in close co-operation with the oyster culture services of the Department of Fisheries, to assist the industry by predicting the settlement of oyster spat, so that clean material to which the small oysters can attach themselves can be put in the water at the right time. In 1952 the hot, dry summer produced very favourable conditions; spawning was good and growth of the free-swimming larvae rapid. Good "sets" were obtained by the industry and were specially welcome because of failures in the two preceding years. The sets were, however, so good as to obscure the differences in the effectiveness of various materials being tested for spat collection. Experiments in 1952 at Shippigan, N.B., showed that dipping spat collectors in DDT in oil did not repel barnacle larvae which sometimes settle in such large numbers as to prevent proper growth and survival of oyster spat.

While the improvement of techniques of spat collection still occupies a prominent place in our investigations, that step is now neither as expensive nor as difficult as the rearing of spat for their first fifteen months safe from enemies, smothering, etc. In a small experiment in 1952 at Malagash, N.S., separated spat placed directly on the bottom in a dyke had a very high survival and a fair growth. The experiment will be repeated on a larger scale as it offers prospects for cheaper production of oysters large enough to plant out on maturing beds.

Preliminary trials of an echo sounder for finding suitable bottom for oyster farming gave promising results. One bed was found in Malpeque Bay and a preliminary exploration of Egmont Bay, P.E.I., carried out.

At Richibucto, N.B., where prospects for oyster farming have been under investigation for two years, trial spat collection was successful in 1952.

OYSTER DISEASES. The disease, which decimated the oyster stocks of Malpeque Bay in 1914, spread throughout the Malpeque-Cascumpeque area in the next few years and was carried, apparently by oyster fishermen, to the Enmore-Percival area on the south coast of the province in 1933, and to the Charlottetown inlets in 1935. The re-establishment of the Malpeque industry since 1929 was based on stock bred from survivors of the original epidemic, and experiments have shown that this stock is resistant to the disease which still

kills a high proportion of oysters introduced from areas where it has not yet occurred. Experiments in Johnston River, P.E.I., now indicate that the surviving native stock there is developing a resistance to the disease about sixteen years after the epidemic—a period similar to that in the Malpeque area.

Oysters from West River, Charlottetown, P.E.I., have for the past three years suffered serious mortalities in storage, making them valueless commercially. Again in the winter of 1951-52 samples were placed in cold air storage in Charlottetown and observed during storage. The results confirmed that symptoms rose to a peak at the same time regardless of the spread of some seven weeks in the times of fishing. About 10% of the oysters died; another 30 to 40% developed symptoms but recovered during storage. It follows that the mortalities are due to infection of the oysters before they are taken from the water, although the symptoms do not develop if they are left there. The basic cause has not yet been discovered.

SPONGES WHICH RIDDLE OYSTER SHELLS. Boring sponges of the genus *Cliona* excavate large cavities in the shells of oysters and scallops. One species (*C. celata*) makes oysters unsuitable for sale in the shell; another species (C. *vastifica*) has been associated with the undesirable "dark meat" condition of scallops. The damaging effects are so serious that investigations were commenced in 1952, centred for the time being on the problem as it affects oysters in Malpeque Bay, P.E.I.

Little has been published on the biology of these sponges or on techniques for their culture, preservation or microscopic examination, and the investigation had to start from scratch. Attention was given to their identification and general mode of life. Investigations have as yet failed to reveal any sexual reproduction or free-swimming stage, and there is evidence that oyster shells usually become infected through contact with other infected shells.

As well as having very fragile shells, spongy oysters often show pustules in various parts of the body, or weakening of the muscle attachment and possibly damage to the hinge ligament. The sponge seems to remain active at temperatures below those at which the oyster can repair its shell so that heavy damage may occur in winter. Single oysters are rarely attacked until they are almost of marketable size, but spat attached to spongy shell may be attacked at almost any size.

Experiments have shown that control measures requiring the raising of the oysters from the bottom, such as exposure to fresh water, may be possible but there seems little hope of methods applicable on the bottom. General studies of the biology of the sponge may show other points of attack, but any but empirical attempts at control must await further information on the reproduction and dispersal of the sponge.

CONTROL OF EEL-GRASS ON OYSTER GROUNDS. In the early thirties a disease killed most of the eel-grass (*Zostera*) in Maritime Province waters and some grounds which were densely covered became so free of it as to be suitable for oyster farming. The eel-grass is now recovering and since 1949 the effects

of eel-grass on oysters and means of controlling eel-grass have been studied. In 1952 these investigations were restricted to observation, mainly in the Malpeque Bay area, P.E.I., of the results of experimental control measures, and to studies of the growth and morphology of the plants under various conditions.

Careful studies of the growth of individual plants showed that growth continued all summer. Seedlings, which were very numerous in 1952, are more susceptible to death by exposure and drying at low tide than are older plants.

An experiment started in 1949 has shown that in 1949, 1951 and 1952 oysters on the bottom grew faster free of eel-grass than among it, and that oysters raised slightly above the bottom grew faster than oysters on it; in 1950, a poor year for oyster growth, no differences were found. It is clear that decreased circulation in dense eel-grass decreases oyster growth.

Areas covered with hard materials such as clam shells, oyster shells, gravel and concrete slabs to control eel-grass still show resistance to reappearance of eel-grass seedlings, probably because of the difficulty of establishing a stable root system. Covering with tar paper over-laid with sand and treatment with Benoclor (in concentrations of 1 gallon or more per 1,000 square feet) were effective in removing the eel-grass initially but left a sand surface in which seeds can germinate, so that such areas can become covered again by new seedlings as well as by encroachment of older plants on the margin. It seems that these treatments may remain reasonably effective for five or six years only.

Soft-Shelled Clams (Mya)

The development of the trade in shelled clam meats ("shucked clams") and the resulting greatly increased demand caused an increase in the Canadian production starting in 1940. The take reached a peak in 1950, the marketed value in that year being well over the million dollar mark and exceeding that of scallops or oysters. The peak was reached by fishing accumulated stocks and expanding to new areas. The decline of the production towards an equilibrium at a lower level was predicted by the Station and is now taking place. The Station's investigations have been designed to lay the basis for maintaining production by bringing new areas into production, by clam farming and by regulation of the public fishery.

Exploration. The Station's explorations have helped the industry to maintain production by developing new areas. Even in 1952 some small producing areas were explored in the Bay of Chaleur area but this phase of the work is coming to a close as all existing stocks are coming into use. Some attention is being given to the development of new methods of taking clams which may permit the use of clams from areas now out of reach because they remain covered at all or most low tides.

Clam farming not profitable. Clam farming, consisting of removing small clams from areas where their growth and survival is poor and planting them in more favourable areas, had long been practised in the United States. Starting in 1944 extensive experiments in clam farming have been carried out by the Station, principally at Sissiboo River, and Petpeswick Harbour, N. S.,

and at St. Andrews. The effects, under various soil conditions, of various densities and methods of planting, of various tidal levels, of digging at various seasons and of many other phases of clam farming have been determined in carefully conducted plot experiments. The results have shown that slow growth and poor survival leave little prospect for profitable clam farming even in our most promising areas and have, in fact, stimulated a similar assessment of the supposedly profitable clam farming in New England, with much the same results. The Station's work in 1952 was limited to examination of the results in an experiment in Pocologan Harbour, N. B., where six bushels of 1¾″ clams planted in May, 1950, yielded in June, 1952, twelve bushels of clams showing an average growth in length of 60% and a 64% survival. This is the most promising result yet obtained but still barely profitable.

REGULATION OF THE FISHERY. The knowledge gained in clam-farming experiments is of great value in attempting to lay the basis for regulations which will maintain the yield of the fishery at its optimum. Discovery that digging destroys about half of the small clams which are left suggested experiments, commenced in 1945, on the effects of the frequency of digging. In plot experiments in three areas with differing types of soil, the yields resulting from semi-annual, annual, biennial and triennial digging are being compared. Results to date indicate that a greater yield results when flats are dug once a year than when they are dug twice a year; results from still less frequent digging are not yet conclusive. The Station is co-operating with the Department in arranging application of these results through experimental regulation of the digging on larger areas.

Consideration of the 2″ minimum size limit in the light of information on growth, natural mortality, destruction by digging and proportions taken throw doubt on its value by itself but indicate its possible value if associated with controlled frequency of digging. Investigations are continuing.

The Station continued to assist the Department in the solution of local administrative problems such as the need for bait reserves and the inadvisability of applying the size limit in areas where growth is unusually poor.

CLEANSING OF SEWAGE-CONTAMINATED CLAMS. Dense stocks of clams in extensive polluted areas constitute a risk to public health through illegal sale and a potential source of valuable supplies if they can be made fit for human consumption. Experiments in the cleansing of such clams by transfer to clean water were carried out in 1951 and 1952 in co-operation with the Department of National Health and Welfare and the Fish Inspection Laboratory, which provided bacteriological mobile laboratories and personnel. Heavily contaminated clams cleansed themselves rapidly when placed in water as cold as 41°F., with salinities between 30‰ and 33‰ and most probable numbers of coliform bacteria less than 20 per cubic centimetre.

Cleansing takes place in three phases: a 24-hour period of rapid cleansing, a 24-hour period with no cleansing and a final phase of 24 or more hours when the numbers of bacteria drop to very low levels. Crowding to a considerable degree has no effect, nor does regular intertidal exposure for 3- to 4-hour intervals. Removal of mud hastens cleansing and broken clams will not cleanse themselves.

After cleansing clams have a higher meat yield and are handled more easily. A floating car was designed for quick loading and unloading under industrial conditions and proved satisfactory. A trial supervised industrial operation is planned for 1953.

Paralytic Shellfish Poison

The Station's major investigations in this field led a few years ago to the adoption of policies which protect the public from paralytic shellfish poisoning with a minimum of interference with the industry, and in recent years the Station has co-operated closely with the Departments of Fisheries and National Health and Welfare in the application of these policies and their extension to new areas. With the establishment of a new branch laboratory of the Fish Inspection Laboratory at St. Andrews late in 1952, the Station is being relieved of all routine aspects of this work. The work is being turned over with clear, complete, up-to-date records of results in this field.

The absence of any rise in toxicity in the summers of 1951 and 1952 was very welcome to the industry but remains unexplained and inconsistent with the past several years.

Razor Clams

In 1951 the Station encouraged trial canning of razor clams from the head of St. Mary Bay, N.S., leading to their first commercial use in the Maritime Provinces. In 1952 this led to a larger production (over 200,000 lb.) which more than offset the decline in the production of soft-shelled clams in Digby County. The razor clam stocks of this area differ from those elsewhere in the Maritimes by having unusually good and consistent reproduction and in living in soil below which there is hard pan which prevents them from escaping from the diggers.

Bait Worms

In 1951 the Station carried out brief explorations for "sand worms" (*Nereis*) and "blood worms" (*Glycera*) which are in high demand in the United States for use as bait in sports fishing. Promising quantities of "blood worms" were found in Yarmouth County, N.S., trial shipments to the New York market were arranged and prospective buyers put in touch with prospective producers. In 1952 shipments valued at about $30,000 were made from Goose Bay, Little River and Yarmouth Harbour, all in Yarmouth County. A digger can take daily in about five hours 600 to 1,000 worms worth one to one and a quarter cents apiece.

Scallops

The problems of the scallop fishery of the Maritime Provinces are of two kinds. In the Bay of Fundy there is an intensive fishery now subject to regulation. Here the need is for a consideration of the value of restrictive measures for maintaining the yield. Elsewhere there are unused scallop stocks to be found and developed. The Station has worked on both these aspects of the fishery.

REGULATION OF THE INTENSIVE FISHERY. Broadly speaking the intensive Digby fishery dates from about 1920, production rising to a peak of over 1,500,000 lb. of scallop meat in 1937 and falling to less than 200,000 in 1950. Efforts to maintain the fishery by regulation have relied mainly on closed seasons and on a minimum size limit. Actually this appears to be another case (like the lobster, oyster and clam fisheries) of a fishery growing and spreading over new grounds, producing a peak yield dependent on accumulated stocks, and finding an equilibrium at a lower level of yield based on annual crops. On this have been superimposed fluctuations caused by known variations of great magnitude in the abundance of year classes. Our task is to sort out these factors and assess the value of regulations.

Investigations since 1934 of the general life history, and more intensive investigations since 1946 of the populations of scallops, have given reasonably good information on growth rates, age composition of the stock, catches and fishing effort. Of recent years, with stocks at a relatively low level, the proportion caught annually is about 25%. Abundance estimated by tagging and experimental fishing in 1949 and confirmed in 1952 by under-water photography was of the order of 0·6 scallops per square yard on one important fishing area. Scallop drags catch about 5% of the scallops in their path. Analysis of this information indicates that protection of small scallops would maintain the yield at a higher long-term level than would unrestricted fishing. This conclusion needs to be re-examined when the scallops are again more abundant and the fishing, consequently, more intensive, as is expected in the near future. An attempt is now being made to obtain information on the natural mortality by observing the numbers of shells of recently dead scallops.

DEVELOPMENT OF A "SAVINGS GEAR". Scallops are shelled at sea and the shells discarded. A size limit based on the diameter of the shell is therefore not enforceable. Furthermore, small scallops are damaged by being landed on the boats and returned to the sea. Protection of small scallops therefore requires a "savings gear" which will not catch them. By experiments started in 1949 it has been shown that if the bags of scallop drags are made of rings with an inside diameter of $3\frac{1}{4}''$ instead of the usual $2\frac{5}{8}''$, they catch only about half of the scallops below 4" in diameter but more of those above that size. In 1952 tests under commercial fishing conditions showed that this gear lasts as long as the standard gear and continues throughout its life to take fewer small and more large scallops. Estimates indicate that the gear is more expensive, perhaps raising fishing costs by about 2% but this is offset by its greater efficiency in catching large scallops and the increase of 10 to 15% in the long-term yield which is expected to result if this gear is used.

FORECASTING TRENDS IN DIGBY SCALLOP PRODUCTION. In 1948 an increase in the catch of scallops in the Digby area was predicted on the basis of an observed correlation between abundance of year classes and the warmth of the water in the year they are spawned. This prediction was confirmed more recently

as scallops too small to use appeared in greater abundance. In the autumn of 1952 this prediction came true; the fleet obtained high catches consisting mainly of scallops averaging about 3″.

EXPLORATION. Only in the Bay of Fundy is there an intensive scallop fishery which might benefit from restrictive measures. Incidental capture of scallops in fishing for groundfish indicates the presence of unused scallop stocks both off the outer coast of Nova Scotia and in the Gulf of St. Lawrence. Very high catches by limited commercial scallop fishing on Middle Ground indicates the possibility of developing a large fishery there and explorations are planned in that area when a suitable vessel becomes available. In the meanwhile explorations have been carried out in the southern Gulf of St. Lawrence where fishing has been sporadic and frequent mass mortalities of scallops have occurred.

Explorations in 1949 and 1950 discovered commercially promising concentrations of scallops in the vicinity of Pictou Island, N. S., and off Richibucto, N. B., but in the former area mass mortalities occurred before good use could be made of the stocks. In order to make possible economic use of the fluctuating stocks of the region the size limit was rescinded there on the Station's recommendation and gear suitable for operation from small boats, long in use in Lunenburg County, was tested and demonstrated.

In 1950 about two square miles of scallops in abundance were found off Richibucto, N. B., all belonging to the 1946 year class and only 2½ to 3″ in diameter. This stock was observed again in 1951 and a 10-day fishing trial was carried out at the end of May in 1952 which showed that fishing could be profitable. The information was released by press and radio and several boats based on Richibucto, N. B., and Miminegash, P. E. I., had profitable fishing in the summer and autumn. As there is only one year class present this fishery is not expected to last long; the total yield is not yet known.

FACTORS INFLUENCING SURVIVAL OF SCALLOPS. The scallop *(Pecten grandis)* on which our fishery depends is a cold-water form. The waters of the southern Gulf of St. Lawrence are very warm in the summer at the surface with much colder water only a few fathoms down. The water movements associated with storms can cause sudden temperature changes on the bottom in the moderate depths where scallops are found, sometimes perhaps raising the temperature too rapidly and too far for the scallops to stand. It has been thought that these unfavourable temperature conditions cause the very severe mortalities which have frequently been observed in various parts of this area.

In 1952 experiments were carried out at St. Andrews in which scallops held at about 50°F. and 59°F. were found to be killed by about 71°F. and 74°F. respectively. Further experiments are planned using scallops held at lower temperatures. On the basis of these results temperatures may be responsible for the scallop mortalities in the region. Other experiments showed that scallops survive salinities far lower than any that occur on the scallop grounds.

Groundfish

The fishery for "groundfish", the species such as cod, haddock and flatfish which are usually caught close to the bottom, is the most important branch of the Canadian Atlantic fisheries. Even in the Maritime Provinces, although less important than the lobster fishery to the inshore fisherman, its total importance is greater and in Newfoundland it dominates the whole fishing industry even more. Groundfish represent the principal present and potential source of supply for the growing trade in fresh and frozen fish and in Canada the most abundant species is the cod.

The Canadian fishery for groundfish is still capable of expansion and, in order to maintain its competitive position, needs to make the most efficient use of available stocks and methods. This need for positive development is for the time being the most important aspect of the problem but the increasing fishing effort by many nations is already affecting the stocks and making it apparent that the possible need for regulation cannot be entirely disregarded. We must have the basis for guarding against either over-fishing or unnecessary restrictions.

EFFECTS OF THE FISHERY ON THE STOCKS. In 1945 an intensive effort was started to obtain reliable and thorough information on when and where groundfish are caught and with what effort, and on the sizes and ages of the fish. Earlier information on growth, migrations and general life history is also being supplemented. In general we are getting reasonably good "vital statistics" on growth, age composition of the stocks, and total mortality rates but still lack the basis for distinguishing between natural mortality and the mortality caused by fishing—a distinction very important to any assessment of the possible value of various measures to restrict fishing.

With the establishment of the International Commission for the Northwest Atlantic Fisheries as an active body, the Station's long-term program in this field assumes an additional importance. The Commission (now in its second year) provides a mechanism for the co-ordination of investigations by the member countries on the groundfish fishery of the region and for international agreement on such restrictive measures as are found desirable. The need for evidence for or against such measures becomes more urgent. Canada, with the greatest interest in the northwest Atlantic fisheries, must play an active part in the Commission's work and the Station's responsibility for investigations, especially in the Commission's Sub-area 4 (the Scotian Shelf and the Gulf of St. Lawrence), is increased. The Station has played an active part in the early development of the Commission's program and in consideration of a proposed experimental minimum-mesh regulation in the Commission's Sub-area 5 (off New England).

The Station's work in this field in 1952 was a continuation of the long-term program of investigation of the fishery and of the stocks, but a few developments may deserve special mention.

The effects of the increasing fishing effort, by United States and other countries as well as by ourselves, are already becoming evident in changing age composition of the stocks we fish. Landings of cod on the Canadian mainland reached a peak in 1946-47 and have since declined to pre-war level. The peak catches depended on accumulated stocks of cod which were fished more intensively than formerly because of increased demand. Recent decrease in the catch per effort indicates decreased abundance of cod on the banks off Nova Scotia and in the Gulf of St. Lawrence. That this is due to increased fishing rather than to smaller production of young fish is indicated by the lower proportion of old fish in the catch. The accumulated stock of the large, old, "steak" cod appears to have been greatly reduced. While this is a symptom of a more intensive fishery and makes it harder to catch paying quantities of fish, it does not mean that restrictive measures are yet necessary.

Information is being obtained on the quantities of small haddock and cod caught by our fishery and discarded at sea. This has a bearing on the possible value of extending the Commission's experiment in the requirement of a minimum mesh in trawls to the grounds of Nova Scotia. Observations made to date on trawlers at sea indicate that only small quantities of cod are discarded but that considerable quantities of haddock are caught and killed but not used.

Cod can be tagged reasonably satisfactorily and more cod tagging is planned as a means of estimating the proportion caught by the fishery. Haddock, on the other hand, suffer such severe mortalities when raised to the surface for tagging that this technique is useless. Preliminary attempts to tag groundfish on the bottom with marked hooks snapped off the line and left in the fishes' mouths met with little success.

The increased abundance of haddock, predicted five years ago on the basis of data on the age composition of the stock and on catch per fishing effort, has continued. In our waters the abundance of haddock year classes varies more greatly from year to year than in the case of cod, making predictions of this sort more significant.

DEVELOPMENT OF INSHORE DRAGGING. The Station's explorations, begun in 1947, have stimulated the development of inshore small-boat dragging, first in St. Mary Bay and the Bay of Fundy and later in eastern Nova Scotia and the Gulf of St. Lawrence. The number of small fishing boats converted to dragging increased from about 50 in 1951 to about 90 in 1952, the most marked increase being in eastern Nova Scotia. Dragging has been concentrated in and about Chedabucto and George Bays, flatfish being important in the former and both flatfish and haddock in the latter. The industry's trend towards accepting smaller flounders has continued in 1952, the minimum size dropping to 10 inches, and this is permitting use of stocks of small, slow-growing flounders in a number of new areas from southwestern Nova Scotia to the Miramichi. Flatfish still constitute over 60% of the catch of this small-boat dragging but there is a trend towards fishing other species, including haddock, catfish, hake and cod. Late in 1951 the Station explored areas in the southeastern Gulf of St. Lawrence and in Northumberland Strait; no actual exploration was done in 1952 but advice to fishermen on areas and methods continued.

Tagging and sampling the winter flounder population in St. Mary Bay, together with statistics of catch and effort, indicate a natural mortality of about 30% and growth in weight of about 33% annually. Data suggest that a higher long-term yield would be obtained by less intensive fishing than in the last three years. It is planned to follow the development of this fishery with further tagging experiments.

Experiments to select the mesh in flounder drags which would leave in the water the flounders too small to be used by the industry indicate that substitution of a $5\frac{1}{2}''$ mesh (between knot centres) for the present standard $3''$ mesh would release most of the flounders shorter than $10''$ now discarded without seriously affecting the catch of marketable flounders. The larger-meshed nets would be cheaper and more efficient.

The Station's experimental Danish seining in 1949 showed that this method was promising for flatfish fishing in Chedabucto Bay, N.S., and gear and hauling equipment were lent to a commercial fisherman for successful trials there in 1951. In 1952 he has continued to use the method with his own equipment and it appears to be more efficient for catching flatfish than dragging with small boats. Its use is limited to places where there are large areas of smooth bottom.

REDFISH DRAGGING FOR SMALL VESSELS. Small redfish draggers have continued to operate successfully in the Gulf of Maine even after fishing there was no longer considered profitable for larger trawlers. The latter now fish redfish profitably close to the Canadian coast, suggesting that small draggers based in our ports could do well in this fishery. The *J. J. Cowie* (over-all length about 65 feet) was used by the Station in 1952 on preliminary trials in an attempt to develop this fishery.

PARASITES. An immature stage of a trematode *(Stephanostomum histrix)* occurs in very small cysts in the winter flounder and has caused some marketing difficulty. Investigations completed in 1952 have shown that the trematode matures in the alimentary tract of the sea raven *(Hemitripterus)*, the wrymouth *(Cryptacanthodes)*, the eelpout *(Zoarces)*, the halibut, and the short-horn sculpin *(Myoxocephalus)*. The youngest immature stages occur in two snails *(Buccinum* and *Neptunea)* where they multiply asexually before passing into flatfish, all six species of which may have cysts. All stages of the parasite are marine and widely spread so that no control can be suggested. Infection is seldom serious and the parasite is harmless to man.

Herring

Except for the small-herring or "sardine" fishery of Charlotte County, N.B., and the winter fishery for larger herring in certain Newfoundland areas, herring catches on the Canadian Atlantic coast are made during short seasons and consist mainly of thin spawning fish. The stocks, again with the possible exception of the "sardines", are lightly fished. If fully used they could support, as in European waters, a large meal and oil, or food industry. Although the development of our herring fishery has apparently been retarded by marketing difficulties, these

difficulties might be overcome if we could catch high-quality herring cheaply. The Station's efforts have been directed toward learning how to find and catch herring.

DRIFT-NET FISHING FOR HERRING IN THE GULF OF ST. LAWRENCE. From 1944 to 1949 the governments of Canada, of the four Atlantic Provinces and of Newfoundland co-operated, through the Atlantic Herring Investigation Committee, in exploration of the Gulf of St. Lawrence in the hope of establishing a large herring fishery. The Committee learned a great deal about the hydrography of the Gulf, showed that several more or less distinct herring populations were present but, in spite of extensive search with sonic sounders and some exploratory fishing, failed to find concentrations of herring for purse-seining or other large-scale fishing. The Station continued the explorations by drift-net fishing from 1950 to 1952.

In 1950 good catches of large fat herring were made throughout the summer; catches per night per net (37½ yards long and 150 meshes deep) averaged 136 pounds, as compared with 50 to 100 pounds in the North Sea with nets twice as deep. In 1951 catches were poor until late in the season when deeper nets were used, and good catches were again made. In 1952, using North Sea nets 360 meshes deep, catches averaged over 300 lb. per net-night and over 400 lb. in some areas. Thus good drift-net catches of fat herring can be made from May to September. There is some commercial interest in these results and it is hoped that herring may be caught profitably for reduction by purse-seining or trawling, if not by drift-netting, in the best areas.

Surface water temperatures where drift-nets were set averaged 14·1°C. in 1950, 15·9°C. in 1951 and 14·4°C. in 1952, the warmer surface water in 1951 possibly explaining the low catches in that year by shallow nets. The average catch per net-night was 83 lb. with moonlight, 237 lb. when dark and overcast and 541 lb. with clear starlight. Herring were largely in the bottom half of the nets on moonlight nights. Good catches of herring showed some correlation with good catches of the small crustacean *Calanus*. When good catches were made fish could usually be recorded by the echo sounder, but not always. Weekly samples of herring were tested for fatness, showing that recovery from the thin spawning condition is very rapid (from 3·5% fat in mid-May to 11·5% in mid-June).

Examination of samples of herring for length, age and number of vertebrae shows that these characteristics have remained stable for several years for the various herring populations. The drift-net herring taken on American Bank off the Gaspé coast from May to September are very similar to those taken in the Bay of Chaleur in May. Drift-net herring from the south-eastern part of the Gulf are different from the above but indistinguishable from the spring spawning herring of the Magdalen Islands and Prince Edward Island.

EXPLORATIONS FOR HERRING OFF THE OUTER COAST OF NOVA SCOTIA. Explorations have been requested by the industry in this area because the inshore summer fishery has had disappointing catches in some recent years. Preliminary

search in 1952 using bottom trawls from the M/V *Harengus* and drift-nets from the M/B *Mallotus* failed to discover commercial quantities in new places. Further explorations over a longer season are planned for 1953.

METHODS OF CATCHING HERRING. Experiments with mid-water and bottom trawls carried out in February, 1952, in Charlotte County, N.B., waters, was followed by the successful commercial use of flounder drags with small-meshed cod-ends for catching sardines. Operated from small boats with a crew of two, the trawls apparently out-fished purse-seines requiring more men and more expensive equipment. The trawls caught the small herring on the bottom in daylight, the seines up in the water at night. The two-boat Larsen mid-water trawl had only moderate success. Experiments are planned in the winter of 1953 with bottom trawls specially designed for herring fishing and with a new design of mid-water trawl.

Attracting Pelagic Fish with Lights

Attempts to catch billfish consistently in commercial quantities were continued in 1952. Gill-nets failed to catch them and the very few observed in nets damaged themselves badly. Experiments with lights and lift-nets in the Japanese manner were not successful in obtaining commercial quantities but yielded information on the reactions of billfish, herring, gaspereau and squid which may yet be of great practical value. Colour had little influence on the effectiveness of lights in attracting these species. Fish tended to stay close to the light better when it was weak (5 watts), concentrating in the periphery of the area affected by bright lights (up to 1,000 watts). The results are sufficiently promising to encourage further attempts. It is interesting to note that viewed from above in these experiments herring always milled anticlockwise and gaspereau always clockwise and that neither could be reversed.

Smelt

Sea smelt are highly prized and relatively easy to market. The annual marketed value of the catch sometimes exceeds $1,500,000 and production seems to be limited mainly by availability of smelts in the sea. A moderate downward trend of the catch (averaging about 1% per year) for the preceding twenty-five years prompted the initiation of investigations in 1941, centred in the Miramichi area which produces about half of the New Brunswick catch and about a third of that on the Canadian Atlantic coast. Means of maintaining or increasing the smelt stocks were sought along two main lines: the improvement of conditions for reproduction and the regulation of the fishery.

Smelt are anadromous fish closely related to the salmon and trout family. They present some of the aspects of the salmon problem in miniature and the investigations have a general as well as a particular interest.

KEEPING THE SPAWNING GROUNDS ACCESSIBLE TO THE SMELT. As summarized in earlier reports, it was soon found that smelt were often crowded below obstructions to such a degree as to reduce not only the proportion of the eggs hatching successfully on any area of bottom but sometimes even the total number. It

was confirmed experimentally that relatively inexpensive removal of small obstructions leads immediately to occupation of a greater area of spawning ground and, consequently, to the hatching of greater numbers of larvae.

SPAWNING, LARVAL PRODUCTION AND THE COMMERCIAL CATCH. The value of such stream clearance depends, of course, not on its immediate effects in increasing the numbers of larvae but rather on its ultimate effects on the abundance of smelts of marketable size. A series of observations is being made to indicate the relationships between the size of the spawning run and the abundance of larvae and between the latter and the abundance of smelt of the same brood when they reach commercial size. As might be expected under conditions of crowding such that area of spawning ground rather than numbers of spawners is the limiting factor, five years' observations show no correlation between the relative size of the spawning run, estimated from visual observation and from special fishing, and the relative abundance of larvae, indicated by the numbers taken in a regular series of tows. Sampling of the commercial catch for age and size composition, coupled with detailed catch statistics, has given a reliable estimate of the total commercial yields from only two broods, those of 1947 and 1948, and more broods must pass through the fishery before the correlation between larval abundance and yield to the fishery can be tested. The ultimate value of stream clearance cannot, therefore, be estimated yet even though we know that it can increase the numbers of larvae.

REGULATION OF THE FISHERY. The crowding of smelts on the spawning grounds and the absence of a correlation between the size of the spawning run and the production of larvae shows that, under present conditions, no benefits can be expected from restricting the fishery to permit more spawners to escape. Tagging and marking showed that the fishery takes a very high proportion (sometimes over 75%) of the smelt entering the Miramichi estuary during the fishing season (i.e. before mid-February). It also indicated that a considerable part of the stock does not enter the estuary until later and is not used. The marking also suggests a high natural mortality rate and there is no evidence that small smelt are so likely to return to the catches at a greater size as to make it pay to leave them in the water. Although it has been shown that the smelt trap-nets are so selective as to make a minimum mesh an effective means of protecting small smelt, it is not clear that this would pay.

DIVISIONS OF THE SMELT STOCK IN THE MIRAMICHI ESTUARY. The marking has shown that the smelt which enter the fishing area in the Miramichi estuary before the fishing season ends at mid-February spawn early in the main branches of the river. Those which spawn later and in the brooks enter the esturay after the fishing season is closed and are not used. Examination of the scales of early and late spawners has shown that the former had grown more in their first year than the latter, indicating that the early spawners were in the main produced by early spawning. Furthermore, the numbers of vertebrae in early and late spawners differ. Thus the Miramichi smelt stock is not a homogeneous unit and it may be that the present closed season is preventing optimum use of the

stock by protecting a part of it which does not contribute importantly to the fishery in any way. As in the case of salmon, we do not know enough of the smelts' distribution and movements in the sea to understand the factors in-involved in the apparent distinction between the early and late spawners.

Trout

The Eastern Brook Trout (*Salvelinus fontinalis*) is the most popular sports fish in the Maritime Provinces, valuable both for the recreation of our people and for the encouragement of the tourist trade. Provincial governments have been much interested in making good angling available and the Dominion government has been active in the field through the Conservation and Development Service of the Department of Fisheries. The aim of the Station's trout investigations, started on an intensive scale about twenty-five years ago, has been the development of methods for maintaining the trout stock and there has been close co-operation with the Conservation and Development Service.

Although complaints by anglers allege a decrease in trout production, the admittedly scanty information on the yield over long periods suggests that the total quantities taken from most waters have not decreased and may, in fact, have increased, and that the individual angler's catch has decreased because many more anglers are now sharing a limited production. The problem is to increase this prodution by positive measures and attempts to do so are showing some promise in our smaller waters in which some control is possible. In general we must evaluate trout production under a variety of natural conditions and develop procedures for overcoming adverse factors.

Early investigations have revealed much basic information on the biology of brook trout in Maritime Province waters. The Station played an important part in the development of poisoning of enemy and competitor fish, first with copper sulphate and later with rotenone, and this has become an effective means of improving trout production in certain shallow unstratified waters.

FERTILIZATION AND CONTROL OF PREDATORS IN NATURAL LAKES. An intensive study of trout production and limnological conditions in eight Charlotte County lakes, which are typical of the infertile lake regions of the Maritime Provinces, showed that their very low yield was caused by a poor supply of nutrient salts. The planting of hatchery stock, whether fingerlings or yearlings, failed by itself to produce good angling in these waters. Experimental fertilization of Crecy Lake in 1946 and of Gibson Lake in 1947 did not produce results commensurate with the cost, an important factor in the failure being the action of predators. Both lakes were, therefore, fertilized again in 1951 and predators controlled in Crecy but not in Gibson.

In Crecy Lake (50 acres; mean depth 8 feet) with a natural phosphorous content of ·015 mg. per litre, the addition in 1946 of 0·4 mg. phosphorus, 0·2 mg. nitrogen and of 0·3 mg. potassium per litre improved the growth of introduced fingerlings so that for the first time they entered the anglers' catches the year after planting. Of the yearlings and fingerlings planted in 1946, 16·7% and 3·6% respectively were caught in 1947 but although the growth continued good the

catches declined in 1948 and 1949 to pre-fertilization levels with a coincident increase in predatory birds and mammals. Control of the latter was started in 1949 and made more effective in 1950 and later. Eels were trapped in 1950 and elvers kept out of the lake by a barrier dam starting in 1951. In 1950 more of the planted stock (28·6% of the yearlings) survived to be caught later, but growth declined. The lake was fertilized again in 1951 as in 1946. The combined effects of fertilization and predator control included survival of almost 20% of the fingerlings planted in 1950 to be caught in 1951 and 1952 as compared with a consistent capture of less than 1% in unfertilized Charlotte County lakes. In Gibson Lake (59 acres; mean depth 13 feet), fertilized again in 1951 but without predator control, there was only a slight improvement comparable with that resulting from the early fertilization of Crecy. In Gibson Lake only 10.2% of the unusually large yearlings planted in 1951 were caught in 1952, as compared with 81·6% of the same stock in Crecy. In Crecy Lake the yield of angled trout rose to 12·5 lb. per acre in 1952; in Gibson it rose only to 1·3 lb. per acre.

These results offer promise for fertilization as a means of improving trout angling only if it is accompanied by predator control. Hatchery stock was used effectively in this instance in which spawning facilities are poor.

PRODUCTION OF TROUT IN FERTILE PONDS. Contrasted with the low yield of lakes in infertile regions, the mill ponds of Prince Edward Island are highly productive. At Montague angling in a 23-acre pond has been recorded for ten years, during which the annual yield to the anglers has varied from 2,400 to 4,700 trout averaging eight to nine inches in length or 22·4 to 44·8 lb. per acre. There is no indication that the catch one year affected the catch the next and the variations in yield must be ascribed to natural causes. Pond formation has been demonstrated in this and other cases as an effective means of providing angling in this province where the brooks are highly productive of young trout but too small to rear them in abundance to angling size. There have, however, been instances in which an over-abundance of small trout seemed to have growth so low that good angling did not result. More information on the effects of density of population on growth and survival is needed before these ponds can be managed to the best advantage.

In Kelly's Pond (2·6 acres) for six years, in Simpson's Pond (2·3 acres) for five years, in Andrews' Pond (3·0 acres) for four years and in Stephenson's Pond (3·0 acres) for three years, plantings of up to 800 yearlings per acre have given yields (final total weight of marked planted trout less initial total weight) up to 48 pounds per acre. The yield has varied greatly without much relationship to density of planting. Although some of this variation is attributable to variation in season, in the character of the ponds and in size of the trout when planted, it seems that predators have played an important part. Control of bird predators is planned in future experiments.

In Kelly's Pond angling was permitted in 1952 before draining the pond in order to learn the effectivenes of angling and to test the estimation of the trout population from the recaptures of marked trout. Anglers considered the fishing became too poor when they had caught only 54% of the introduced and 10% of the slightly smaller native trout, the total take being 600 trout

in five days during which the catch per rod-hour dropped from 2·7 to 0·1. It is interesting to note that the native trout were much more difficult to catch than the planted trout, and some of the latter much more difficult than others.

POPULATIONS AND MOVEMENTS OF TROUT IN A PRINCE EDWARD ISLAND STREAM. As noted above ponds on Prince Edward Island provide good trout angling by providing room for the abundant small trout of the brooks to grow to angling size. Their effectiveness for this purpose has been recognized and many dams are being built or re-built. On the other hand small trout also go to sea, grow there and return as highly-prized sea trout. As many of the dams are necessarily close to the head of tide, they might interfere with the production of sea trout. An experiment is in progress to show the effects of a dam on the population of the brook as a whole, including that part which goes to sea.

Since June, 1946, a two-way fish trap has been operated at the mouth of Ellerslie Brook which is about five miles long. Trout are counted, measured and tagged as they enter and leave the brook. As many as 5,000 trout have passed through the fence in a year. Since 1950 a second two-way trap has been operated at what will be the head of the proposed pond. A careful creel census has shown that from 1,000 to 2,000 trout have been angled each year, mostly in their third year of age. Most of the trout which pass through these traps have been caught again by anglers, by the traps, or by special fishing to estimate the population, but from a quarter to a half disappear without record. It is believed that fish-eating birds play an important part in this natural mortality, 16 tags having been found in two Great Blue Herons. Populations of trout and young salmon have been estimated by seining and electrical fishing in sample areas selected on the basis of a detailed survey. The estimated populations have varied between about 4,000 and about 15,000 trout fingerlings, between 5,000 and 10,000 older trout, and between 1,500 and 11,000 salmon parr.

A dam which will make a five-acre pond was completed across Ellerslie Brook at the head of tide in October, 1952. It is so constructed that the pond can be drained to the original stream level. Provision has been made for a screen and a fish ladder. The operation of the traps, creel census and population estimates will be continued. At first trout entering from the sea will be liberated in the pond, later they will be barred from the pond, and still later allowed to enter through a fish ladder . This will give information on the effects of the dam on the movements and numbers of the trout, and on the efficacy of the fish ladder.

Salmon

The Atlantic salmon supports a commercial fishery on the Canadian mainland which has an annual value of more than $1,000,000. It apparently contributes even more to the income of the community through its importance to angling and the tourist industry. The Dominion government has responsibility for the administration of the commercial fishery and expends much effort to maintain the stocks through its protection services and through such fish cultural measures as the operation of hatcheries and maintenance of fish passes. The Provincial governments are interested through the tourist trade and, in some cases, the leasing of angling privileges.

Statistics on the commercial catch show that the abundance of salmon in coastal waters has varied greatly. From a high of about 6,600,000 lb. in 1874 the catch fell to 1,100,000 lb. in 1881; from 1,600,000 lb. in 1920 it rose to 5,000,000 lb. in 1924, fell to 2,300,000 lb. in 1928, rose again to 5,400,000 lb. in 1930 and then fell steadily to 1,400,000 lb. in 1945, since when it has remained below 2,000,000 lb. These fluctuations have had their counterparts in other areas and there is no reason to attribute them to fishing. The recent decline has, however, caused much concern and some demand, especially on the part of anglers, for more restriction of commercial fishing. The Station has played a major part in the efforts of the Department of Fisheries, through the Co-ordinating Committee on Atlantic Salmon, to bring about a more thorough co-operative attack on the salmon problem by all concerned. The combined program of administration, culture and research was reviewed at a special meeting in the summer of 1952 and is being expanded.

The first objective is to learn how to produce more salmon and this involves many activities concerned mainly with the life of salmon in fresh water where it is possible to influence the conditions for its survival. Sound administration also needs more knowledge of how one branch of the fishery affects another, involving the life and movements of salmon in the sea regarding which we know so little. The Station's investigations are concerned with both these aspects.

THE PLANTING OF HATCHERY-PRODUCED FINGERLINGS. The operation of hatcheries to produce salmon fingerlings for planting is a long-established practice which may have value in waters where natural production of young salmon is less than enough to make full use of the capacity of the waters to rear smolts. Experiments have been carried out to determine how densely fingerlings should be planted to get the best results.

The scattering of fingerlings along long stretches of stream is difficult and expensive and it is therefore usual to plant them fairly densely at accessible points —a practice which has been subject to some criticism. In an experiment started in 1949 three similar stretches of the Pollett River, N.B., above Gordon Falls were seeded in three successive years with 4,000 marked fingerlings each, in concentrations of 5, 50 and 500 per yard of stream length, the concentrations being rotated among the sections. The final crop of two-year-old smolts was counted through a fence in 1952, leaving only one crop of less numerous three-year-olds. The experiment shows no effect of degree of dispersal at planting within these limits. It is noteworthy that in this experiment in an area where eels are scarce and merganser broods were removed, 28% of the planted fingerlings survived to migrate seaward as smolts.

An experiment to discover the optimum number of fingerlings to plant in the 11-mile stretch of the Middle Pollett River, above an impassable dam and below an impassable falls, was commenced in 1942 but abandoned when it was found that mergansers kept the numbers of the resulting smolts at a low level regardless of the numbers of fingerlings planted. The experiment was resumed in 1950 with the birds controlled, 246,000 fingerlings being planted in 1950 and 925,000 in 1952. A lighter planting is planned in 1953.

SMOLT PRODUCTION FROM SPAWNING OF KNOWN NUMBERS OF ADULTS. Restrictions on salmon fishing are mainly for the purpose of assuring that enough spawners reach the spawning grounds to make full use of the capacity of the streams to produce salmon smolts, and yet little information is available on the numbers of parent salmon needed. After determining the smolt production resulting in the Middle Pollett from various numbers of fingerlings, it is proposed to determine the production from known and controlled numbers of spawning adults. A Denil-type fishway with a trap at its upper end was installed by the Conservation and Development Service for this purpose in 1950 at the dam barring the Middle Pollett to salmon. Small runs were recorded in 1950, 1951 and 1952. Information on numbers of spawning salmon and of the resulting smolts is also being obtained elsewhere.

CONTROL OF PREDATORY BIRDS TO INCREASE SALMON PRODUCTION. The most promising means of increasing salmon production which has emerged from the Station's investigations is the reduction of the numbers of mergansers. An experiment on a branch of the Margaree River in 1937 and 1938 had indicated its value and a more thorough experiment was carried out on the Middle Pollett River, N.B., starting in 1947. With the counting of the 1952 smolt run through the trap at the lower end of the 11-mile section, results are now available from four plantings of fingerlings with protection from birds and from five without. The mean production with bird control was 19,000 as contrasted with 2,200 without. The average survival of fingerlings to the smolt stage was 8% with the birds controlled. An intensive program of seining and electrical fishing has shown that there was some increase in the numbers of other species of fish when bird control was started but that the populations of salmon enemies or competitors, including eels, reached an equilibrium without becoming so numerous as to offset the beneficial effects of merganser control.

On the Miramichi River, N.B., where smolt counting fences have been operated on the Northwest Miramichi and Dungarvon branches since 1950, merganser predation appears to have been heavy on both branches up to 1950 when merganser control was started on the Northwest alone. Estimation of the relative abundance of young salmon by seining in the Northwest since 1950 and in the Dungarvon in 1952 indicates that bird control increased the density of large salmon parr by about four times.

In this area a co-operative study of the means and effects of merganser control has been undertaken with the Canadian Wildlife Service assisting in the study of the distribution and habits of the birds, the Conservation and Development Service of the Department of Fisheries carrying out the merganser control and the Station studying the effects of the control on salmon stocks and giving some general supervision. The aim of this co-operative effort is to develop merganser control into an acceptable, practical procedure.

A survey of the St. Mary River, N.S., in 1952, in preparation for experimental bird control starting in 1953 confirmed the suitability of the river for this purpose. Evidence of serious merganser predation was found and the river is readily accessible.

The general study of the food of mergansers is being continued; the stomach contents of 662 American Mergansers and 58 Red-Breasted Mergansers from a number of streams have now been examined. The Station's investigations indicate that predation by mergansers limits the production of salmon smolts in most Maritime Province streams. A bulletin is in the press on the habits of kingfishers and of their effects on salmon production, which are considered to be much less important than those of mergansers.

EELS AS PREDATORS ON YOUNG SALMON. Electrical fishing has shown that eels are as abundant as salmon in some salmon waters and are potentially serious predators and competitors. In July and August, 1952, at twelve sites on four New Brunswick streams the numbers of different species of fish were estimated in closed-off sections of stream and the eels removed after a night's feeding and their stomach contents analysed. This preliminary investigation confirms the possible importance of the eel as a predator on young native salmon. Further observations have also been made on the predation of eels on newly planted salmon fry.

MEASURING SMOLT RUNS. The attempt to develop means of estimating the number of descending salmon smolts was continued. The use of two traps, one to mark a sample of the run and a second to discover some distance downstream what proportion is marked, was tried again. The results of three years show that these estimates are reliable only within wide limits, the main difficulty being to catch any considerable proportion of the smolt run with fences which do not cross the entire river. Because of freshet conditions, lumber drives, etc., the complete fences are so difficult to maintain on some rivers that experiments are being continued in the hope of developing some means of leading smolts into the partial fences.

MARKING SMOLTS TO STUDY MOVEMENTS OF SALMON IN THE SEA. Although tagging of adult salmon has revealed something of their movements in the sea and of the influence of one fishery on another, the picture as a whole remains obscure. Young salmon can be studied in fresh water up to the time they enter the sea as smolts. They then disappear from view until they reappear in commercial catches as grilse or larger salmon. During this interval we do not know what proportion of them move away from the vicinity of the river nor how far; nor do we know the source of the salmon entering any river, although it is usually assumed that they are returning to their "home" river where they were produced. In order to obtain information on the movements of salmon of known origin and on their contribution to various fisheries, the marking of smolts on a large scale is being attempted in the Miramichi River system.

Fences have been operated on the Northwest and Dungarvon branches since 1950. In 1950 both were too late for the main run and only 8,231 smolt were marked; in 1951, 48,373 were marked; in 1952 a combination of freshets and timber drives prevented efficient operations and only 1,109 were marked. Some of those marked in 1950 reappeared as grilse in 1951 and larger salmon in 1952; some of those marked in 1951 reappeared as grilse in 1952 and are expected as larger salmon in 1953. In 1951, with so few marked fish extant, no special

search was made other than observations in our own counting fences. In 1952 the program was publicized and rewards offered, information solicited from anglers by personal interviews, an observer assigned to the commercial fishery in the Miramichi area and some special fishing carried out in the estuary. It is planned in 1953 to sample the commercial and angling catches much more widely in co-operation with the Quebec Department of Fisheries and the Newfoundland Station and it is hoped that large-scale smolt marking will be carried out by each of these on a local river.

Only preliminary results are, of course, available as yet. A total of 149 marked in 1950 and of 478 marked in 1951 have been recovered. So far these reports give reliable indication only of the recapture of these salmon in the Miramichi area. The return of the grilse predominantly to the branch from which they came is indicated by the recapture in the Northwest trap of 225 fish marked there and only 3 from the Dungarvon, and the recapture in the Dungarvon trap of 91 fish marked there and none from the Northwest. Recaptures by anglers and the commercial fishery did indicate some wandering.

OTHER INVESTIGATIONS. In the course of these major investigations there has, of course, been opportunity to study many other aspects of the biology of the salmon. In the Miramichi area adult salmon are being tagged in the estuary and at the counting fences on the Northwest and Dungarvon branches to throw light on their movements within the river system and on the possible distinction between "early-run" and "late-run" parts of the stock. Observations are being made on such matters as when grilse and large salmon pass up- and downstream and in what numbers.

Cod-Worms and Seals

The immature stage of a round-worm (*Porrocaecum decipiens*) occurs in the flesh of cod and several other species of fish and constitutes such an important hindrance to the marketing of cod in fresh and frozen form that a major effort has been made since 1945 to learn the complete life history of the worm and discover control measures.

LIFE HISTORY OF PORROCAECUM DECIPIENS. Early in these investigations it was shown experimentally that when fish flesh containing these immature worms is fed to harbour seals they mature in about three weeks. The mature worms have since been found in nature in the stomachs of harbour, grey and harp seals.

No indication was found of what happened to the eggs of the worms after passing out of the seals until 1952 when small immature worms of this general sort were found in mysids (small crustacea) in the Bras d'Or Lakes where the cod-worms are unusually abundant. An attempt to feed infected mysids to cod failed to produce a measureable increase in the numbers of worms in the cod. In the late summer of 1952, however, harbour seals were fed with worms taken from cod and their faeces containing round-worm eggs were fed to mysids in which, as a result, young round-worms developed similar to those found in mysids in the Bras d'Or Lakes and similar to but smaller than the immature worms found

in cod. It is planned to test the life cycle more thoroughly by feeding infected mysids to cod again, but there is in the meantime a strong indication that eggs from mature worms in seals develop in mysids, that when these are eaten by fish the worms grow in the fish and when the fish are eaten by seals the worms mature in the seals.

COD-WORMS IN SEALS. Mature *Porrocaecum decipiens* have been found to occur generally in the stomachs of harbour seals. Harp seals were thought for some time to be relatively free of cod-worms when in our waters, none having been found in harp seals on their southward migration in early January, or during the whelping and mating season (late February to mid-April) when they are not feeding actively. Harp seals feed actively in the Gulf of St. Lawrence only from about mid-January to late February and from mid-April to some time in June. Mature cod-worms have now been found in their stomachs during both these periods. The relatively small numbers of worms in the harp seal stomachs, most of them immature, and the harp seal's short sojourn in the Gulf, indicate that in spite of their great numbers harp seals are not as important as harbour and grey seals as hosts to the cod-worms in this area. Very few *Porrocaecum* and no mature specimens were found in the stomachs of 32 harbour porpoises examined in the Bay of Fundy in 1952.

POOR PROSPECTS FOR CONTROL OF COD-WORMS BY REDUCTION OF SEALS. Investigations indicate that harbour seals which breed in early summer in accessible areas could be reduced in numbers and that the increase in the bounty on adults of this species from $5.00 to $10.00 has caused a bigger kill of the breeding stock. Prospects are poor, however, for reducing the numbers of the large grey seals which are important hosts of cod-worms in the Gulf of St. Lawrence. These seals are more wary, scattering when hunting is intensive, and have their pups in mid-winter in places very difficult to reach. Further attempts to find and attack them in these places are planned.

Harp seals can shed cod-worm eggs in the Gulf of St. Lawrence only in very cold water, being absent at other periods. Experiments in 1952 suggested that long exposure to low temperature delays, and may even prevent, development of the eggs but these results are not yet conclusive enough to indicate that harp seals are not an important source of worm infection in this area. The possibility of control thus becomes very doubtful.

Harp Seals

The Newfoundland fishery for the harp or Greenland seal had an average take of about 250,000 from 1895 to 1911 and of about 160,000 from 1912 to 1940. During the war the take was low but increased rapidly after 1946, both Norway and the mainland of Canada entering the fishery. The increasing catch caused concern about the possible need for restricting the fishery to protect the stock. Active investigations by this Station of the populations, movements and general biology of the harp seal were started in 1949.

Aerial photography of the breeding concentrations or "patches" in the early springs of 1950 and 1951 led to an estimate of pup production on the Front (east of Newfoundland) at about 43,000 annually which, with numbers of adults

and immature both about twice this level, means a total population of about 2,150,000. The estimate for the Gulf of St. Lawrence population was about half this number. The kill of pups in 1951 east of Newfoundland rose to about 240,000, leaving only 180,000 pups to replace a kill of 30,000 immatures and 80,000 adults and the natural mortality of the stock (itself about 170,000 at 10%). It appeared that the fishery could not continue at this level without reducing the stock, and the need for restrictions was seriously considered. The 1952 kill was, however, considerably smaller, making the need for restriction appear less urgent.

Age estimation by examination of rings in the dentine of teeth has been applied successfully to this species. Examination of teeth and reproductive organs in large random samples netted in the Strait of Belle Isle during the southward migration has shown that about 34% of the females mature at 3 years of age, about 38% at 4 years, about 22% at 5 years and the remainder (6%) at 6 years, and that most males mature at about 6 or 7 years of age. Histological examination of ovaries and testes is now proceeding to check these conclusions. Age distribution in the samples indicates a total mortality rate in the Gulf of St. Lawrence population of about 22% after maturity. The sampling of stocks both at the breeding patches and at the Strait of Belle Isle is being continued.

With the fishery taking about all that the stock on the Front can stand without reduction, and with a less intensively hunted stock in the Gulf of St. Lawrence, it is important to know whether these stocks are distinct or whether the former can be replenished from the latter. Emphasis is, therefore, being placed on the tagging of pups in both populations. About 950 have been tagged by Norwegian and Canadian workers since 1929 and more tagging is planned in the spring of 1953. The returns from the north are all from West Greenland, some of the pups reaching that area in three months. No seals tagged on the Front have yet been taken in the Gulf or vice versa; one tagged on the ice in the Gulf in 1950 was taken two years later at Neil's Harbour, N.S., about 50 miles away.

The Station has played a major part in discussions with the Canadian sealing industry and with representatives of Norway, Denmark and France on the need for regulation of the fishery and for research. Exchange of plans and results has been arranged with Norwegian and Danish investigators. The Newfoundland Fisheries Research Station has assisted in sampling the stocks on the Front and in tagging there.

Development of Fishing Equipment

Work on the development of fishing gear has been reported in connection with various investigations outlined above. Further tests of the value of a "tickler chain" in flounder dragging again gave slightly better average catches with it than without, but catches were so variable as to leave the result inconclusive. A nylon drift-net without special heat treatment did not show any consistent superiority over cotton nets in catching herring and suffered serious slippage and distortion of meshes.

Of great potential value is the development of an inexpensive instrument to measure the tension in towing warps. It consists of a helical spring operating inside a metal cylinder. In preliminary tests, when a 35-foot flounder drag was towed by the *Mallotus* (55 ft.; 106 h.p. Cummins high-speed diesel) there was a pull of 200 to 300 lb. in each warp at normal towing speed (800 to 900 r.p.m.) and 500 lb. with the engine at full speed (1400 r.p.m.). When a *¾-35 Yankee* trawl with a 51-foot foot rope was towed by the *J. J. Cowie* (65 ft.; 100 h.p. Caterpillar medium-speed diesel) there was a pull of 700 to 800 lb. on each warp at normal towing speed (450 r.p.m.) and 1,000 lb. at full speed (900 r.p.m.). It is planned to make a general study of the pulls required by towed gear of various types and the pulls delivered by boats of various sizes, designs, powers and propellers. It is believed that this information will be very valuable to the development of inshore dragging with small vessels, to the design of boats and gear and to the formulation of policies for the improvement of boats and gear.

New or Unusual Records of Occurrence.

New or unusual records in 1952 included a Beluga at Mace's Bay, N.B., in June, Sea Horses *(Hippocampus hudsonius)*, Trumpetfish *(Fistularia tabacaria)*, Chub Mackerel *(Pneumatophorus grex)*, and Moonfish *(Vomer setapinnis)* from St. Margaret Bay, N.S., in September, and several other species of fish and invertebrates.

Hydrography

The hydrographic investigations of the Atlantic Oceanographic Group, with headquarters at the Station, are of basic importance to the Station's work and close co-operation between the Station and the Group continued. The work of the Group is summarized in the report of the Joint Committee on Oceanography.

The program of regular quarterly cruises, making representative hydrographic sections of the waters of the Bay of Fundy, Scotian Shelf and Gulf of St. Lawrence, which was developed by consultation between the Station and the Group, remains one of the Group's most important activities. It is supplemented by a long-term program of more frequent observations at nine coastal points. As these projects continue they are laying the basis for an understanding of the hydrographic changes responsible for many of the changes in abundance and movements of the organisms with which the Station's work is concerned. We hope that eventually, although perhaps in the distant future, prediction of these hydrographic changes will become possible. In the meanwhile, knowledge of them helps to explain changes in fisheries and to distinguish those which are man-made, and possibly controllable, from those which are natural.

The Group has co-operated with the Station in obtaining hydrographic information associated with a number of investigations, including those on herring drift-netting, occurrence of lobster larvae, and mortalities of scallops.

Co-Operation with Other Bodies

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES. All of the ten countries which concluded a convention in 1949 "for the investigation, protection and conservation of the fisheries of the northwest Atlantic Ocean" have now completed the ratification of the convention. A majority of the countries interested in the fisheries in each of the Commission's Sub-areas have now become members and action by the Commission is possible not only in Sub-area 5 (off New England) in which Canada's interest is only moderately great, but also in Sub-area 4 (Scotian Shelf and Gulf of St. Lawrence) and Sub-area 3 (Grand Banks and off Newfoundland) which are very important to our fisheries. As it is the expressed policy of the Commission to fulfil its purposes in so far as possible by co-ordinating research by the various nations themselves, the work of the Board's two biological stations on the Atlantic coast must be closely related to that of the Commission. The development of the Commission's membership to the stage where action is possible in the areas on which the Canadian fishery depends increases the value and urgency of the work of the two stations in the groundfish field.

At the Commission's second annual meeting, at St. Andrews, N.B., in early July, 1952, special attention was paid to the development of an adequate program of research for the Convention area as a whole. A special committee of one or two scientists from each country was appointed to draft a program. The Station's Director, as scientific adviser to the Canadian Commissioners, represented Canada at a meeting of this committee at Copenhagen at the end of September. He was also re-elected chairman of the Commission's Standing Committee on Research and Statistics.

The Station continued to play an active part in co-operation with scientists of the U.S. Fish and Wildlife Service in the formulation of recommendations of an experimental minimum mesh size for otter trawlers engaging in the haddock fishery in the New England area (Sub-area 5), the Director and members of the staff attending a third meeting for this purpose at Woods Hole in January, 1952. The Director, on behalf of the Department of Fisheries, discussed the proposals with the industry at Halifax in February and, with Mr. McCracken, attended the meeting of Panel 5 at Ottawa at the end of that month, at which the proposal was approved and recommended to the Commission which approved it at its meeting in July. The Station will continue to co-operate with the U.S. Fish and Wildlife Service in planning and interpreting the research to follow the results of the experiment.

At its July, 1952, meeting the Commission postponed the final selection of the site for its headquarters and the Station is providing space and some facilities for another year. Dr. Martin, on leave from the Station's staff, acted as the Commission's first Executive Secretary until November, 1952, when he was replaced by Dr. E. M. Poulsen of Denmark. Dr. Martin played a very important part in the development of the Commission's organization and work, especially good progress being made in the field of fisheries statistics.

PUBLIC HEALTH. The close co-operation between the Department of National Health and Welfare, the Department of Fisheries and the Station continues to bear fruit. The Interdepartmental Shellfish Committee, of which the Director is Chairman, Mr. Logie secretary and Dr. Medcof a very active member, continued to discuss and plan the investigations and the administrative policies necessary to protect public health with a minimum of interference with the commercial use of the shellfish. The Committee's work has concerned mainly the various public health problems of the oyster, clam and scallop industries, including closure of polluted areas, self-purification of polluted shellfish, closures of areas when paralytic shellfish poisoning is a threat, proper sanitary control of processing and transport and many other matters important both to the public health and to the fisheries. In 1952 the Station, the Fish Inspection Laboratory and the Laboratory of Hygiene co-operated in developing a practical procedure for the self-purification of clams which it is hoped to put into commercial practice in 1953.

CO-ORDINATING COMMITTEE ON ATLANTIC SALMON. This Federal-Provincial advisory committee was formed in 1949 to co-ordinate research, regulation and development work by the governments of Canada and of the five Atlantic provinces. The Station has played an important part in the Committee's work, the Director being chairman and Dr. Kerswill secretary. At a special meeting called by the Deputy Minister of Fisheries in July, 1952, at Ottawa plans were laid for expansion both of research and of development work and the Station, through Dr. Kerswill, was given increased responsibility in the development of this expanded program as a whole.

PROVINCIAL GOVERNMENT DEPARTMENTS. The expanding research activities of the Quebec Department of Fisheries in the northern parts of the Gulf of St. Lawrence are of special interest to the Station's work. Exchange of information and mutual assistance is being arranged in a number of fields, especially hydrography, salmon (see above) and herring. The Station is in contact with the fisheries administrations of the three Maritime Provinces and Newfoundland with many instances of exchange of information and advice. The Station co-operated with the New Brunswick government (through Mr. R. A. Tweedie) in exploration of the prospects for developing salt-water sport fishing in the Passamaquoddy Bay area.

Assistance to Other Scientists

Miss Constance MacFarlane of the Nova Scotia Research Foundation again used the Station's facilities for studies on the life histories of seaweeds.

Facilities were also provided again for work on the comparative cytology of blood by Miss Mary E. Needler for Dr. Vibeke Englebert of the University of Toronto.

Dr. W. B. Scott, of the Royal Ontario Museum, and two technicians, were assisted in the collection of material for displays on marine fish being prepared in co-operation with the Department of Fisheries.

Dr. Althea Warren of the University of New Brunswick was given assistance in obtaining material for research on the hardening of fish eggs.

Live four-spine sticklebacks (*Apeltes quadracus*) were shipped successfully to Mr. J. van Iersel of Leiden University, Holland, for use in a comparative behaviour study of other members of the stickleback family.

ACKNOWLEDGEMENTS.

The members of the staff of the Station are grateful for the continued cooperation of industry, of universities and of agencies of both Federal and Provincial governments, and especially that of other branches of the Dominion fisheries service. They wish also to thank the scientists in other countries from whom they have received assistance.

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